Removal of Lead, Copper, and Colour from Wastewater Using Raw Coconut Shell, Activated Carbon and Activated Nanocomposite

Yusuf Sarkingobir [1]
Department of Biology Shehu Shagari College of Education Sokoto state, Nigeria

Malami Dikko [2]
Sultan Abdurrahman School of Health Technology Gwadabawa, Sokoto state, Nigeria

Zubaida Abubakar Ladan [3]
Department of Biology Shehu Shagari College of Education Sokoto state, Nigeria

Abstract

Water is essential for diverse uses, but it's quality is always compromised by anthropogenic activities. Lead, copper and colour are among the pollutants disturbing water quality. This paper investigated the removal of these elements from wastewater using Raw Coconut Shell (RCS), Activated Carbon (AC) and Activated Nanocomposite (ANC) using standard methods. The finding revealed that AC had the highest activity in removing lead, copper and colour from the wastewater then ANC and lastly RCS.RCS need to be activated to enhance its surface for more adsorption activity.

Keywords: Lead, *copper,* activated carbon, raw coconut shell, activated nanocomposite and wastewater.

1. INTRODUCTION

Water is a vital resource that is useful in diverse activities of life. There is need for water quality to sustain the said activities, but the anthropogenic activities over the years has continued to compromise (pollute) the quality of the scarce water resource at our disposal (Mohan and Sheena, 2019). Wastewater can be produced due to industrial or domestic activities. They contain many contaminants that present potential health risks to biological systems and in turn public health. Chemicals (such as pesticides), pathogens (such as *Cryptosporidium*, *Giardia*, *Legionella*, enteric viruses), pharmaceuticals (like estrogen), endocrine disrupting chemicals (like dioxin, pthalates), personal care products and surfactants; can easily be found in waste water at chronic levels, thereby causing public health concern (Theoye *et al*., 2018). In the move to purify water, exposure to various disinfectants (such as chlorine,

hydrochloric acid, calcium hypochlorite, ozone, and chlorine dioxide), anticoagulants (such as aluminium sulfate) can lead to hazards to biological system (Israel Institute of Occupational Safety and Hazards, 2009).

Parables, some hazardous pollutants of water are the heavy metals such as Lead (Pb) and Copper (Cu). Pb exposure is associated with many adversities to biological system such as haematological dysfunction, central nervous system abnormalities, decreased intelligence, reproduction problems etc. (Buah and Dankwah, 2016; Ojekunle, 2017). Whereas, Cu exposure above 2mg per day can lead to many problems such as gastrointestinal distress, anaemia, liver and kidney disruption (Washington State Department of Health, 2016). Therefore, diverse conventional methods are available to remove heavy metals and colours from polluted water, but they are marked with disadvantages. These disadvantages include expensiveness, toxicity, and lack of accessibility (Amuda and Ibrahim, 2007; Buah and Dankwah, 2016).Thus, there is need to find material such as coconut shell from our local disposal to treat water. Using coconut shell will avail in having low-cost, availability and reduction of toxicity and environmental waste. The objective of this paper is to determine the ability of RCS, AC and ANC in removing Pb, Cu and colour from wastewater.

2. MATERIALS AND METHODS

2.1 Sample Collection, Identification and Treatment

Sample of Raw coconut shells were collected from Gwadabawa Central Market, Sokoto State, Nigeria. Then, coconut shells were washed thoroughly with tap water and with sterile distilled water to remove all traces of impurities, dirt, dust and salts. The samples were dried in an oven at 100^{o}C overnight. The dried coconut shells were pulverized into smaller particle sizes with a mortar and pestle; then sieved into granular particle sizes of 75 µm and150 µm (Abubakar, 2020).

2.2 Processing

Carbonization Process

Carbonization process was achieved by weighing 15g fresh batch of sample in clean silica crucibles and heating in an air tight oven at 500^{o}C for 5 hours. The equation for the process was shown below:

Raw coconut shell $\xrightarrow{500^{0}C,\ 5\ \text{minutes}}$ C+CO_2 ----------------------------(1)

Carbonization (Abubakar, 2020).

Activation Process

15.0g of the carbonized coconut shell was weighed into three crucibles. The crucibles with its content were heated in a muffle furnace at 450^{o}C for a period of 3hours. The activated sample was allowed to cool to ambient temperature; the sample was washed with de-ionized water, filtered with Whatmann No.1 filter paper and then dried in an oven at 500^{o}C for 6hours. The equation for the process was shown below:

Carbonized-coconut shell $\xrightarrow{4500C\ 3hours}$ AC + CO_2 --------------------------(2)

Activation (Abubakar, 2020).

Adsorbent Experiment

The adsorbent ion phase was made using burette and a cotton wool. Small quantity of the wool was inserted into the burette and 4.0 g of the adsorbent (activated carbon was filled on top of the cotton wool. 50cm^3 of the working solution was transferred into the burette filled with the adsorbent. The burette tap was opened slowly and filtrate flows low at the rate of 7 drops per minute. This procedure was repeated for raw coconut adsorbent as well as for other working solution. The concentration of the residual or remaining metal ion in the filtrate after adsorption process was determined using Atomic Absorption Spectroscopy (Abubakar, 2020).

Preparation of Silver Nanocomposites for Activated Carbon 250cm^3 0.001m (1mm) solution of $AgNO_3$ was prepared. 100cm^3 of the prepared $AgNO_3$ solution was transferred into a 250ml beaker, where 0.05 of polyethylene glycol (PEG) was added. The mixture was stirred on a magnetic stirrer at 60^{0}C continuously until the initial colour changes to a light yellow. This takes place about 6hours. After about 5 minutes of colour change, 4g of activated carbon was dispersed into the AgNCs solution. The stirring was allowed to continue for 45min, and then the AgNCs – activated carbon

was filtered and wash with de-ionized water and dried at 60^0C for 4 hours (Abubakar, 2020).

3. RESULTS

Table 1: Concentration for Adsorption of some heavy metals by Atomic Absorption Spectroscopy (AAS)

Adsorbent Materials (g/dm^3)	Initial Concentration for Cu	Copper	Initial Concentration for Pb	Lead
Raw Coconut Shell	21.1414	19.2228	28.3497	13.4420
Activated Carbon	21.1414	0.1139	28.3497	0.0921
Activated Nanocomposite	21.1414	7.1586	28.3497	3.4188

3.1 Ultra-violet Visible Spectroscopy Analysis

The UV-Visible spectra obtained for the raw, activated carbon and activated nanocomposite samples were shown in Figure 1.

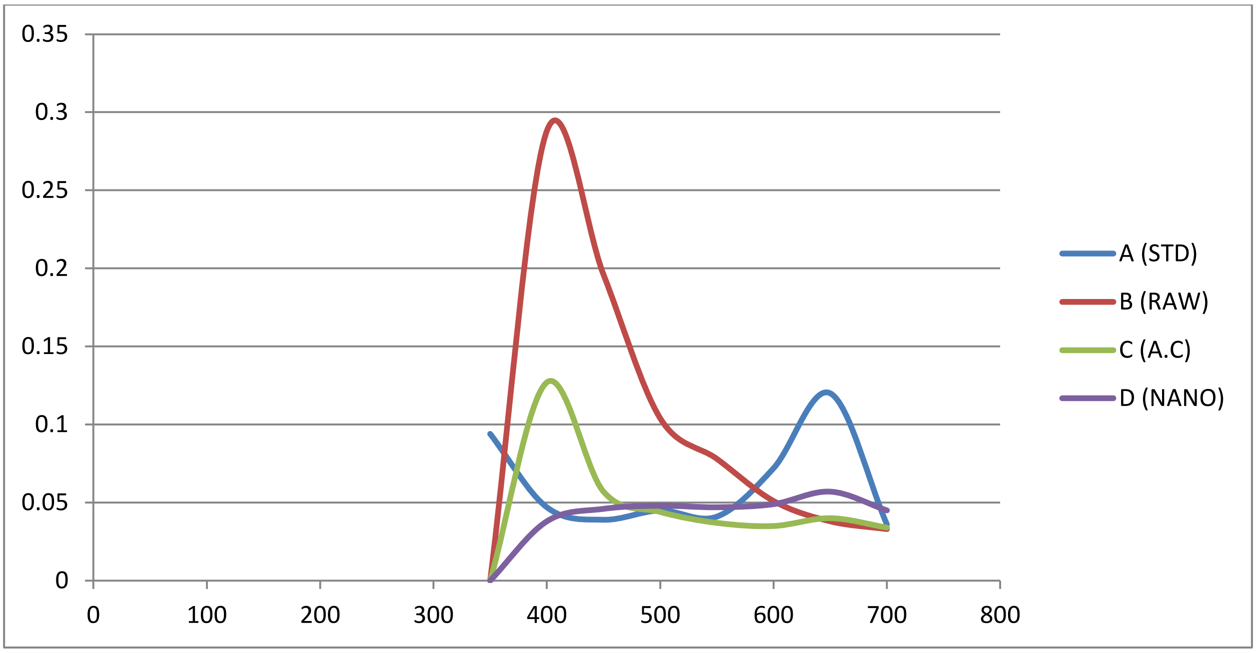


Figure 1: UV-Visible for Raw Coconut Shell, Activated Carbon and Activated Nanocomposite.

4. DISCUSSION

The result comparing the adsorption of some heavy metals (Cu and Pb) using atomic absorption spectroscopy was shown in table 1. The material with the highest adsorption of Cu and Pb was the Activated Carbon (AC) (from 21.1414 to 0.1139 in Cu; and from 28.3497 to 0.0921 in Pb), then the Activated Nanocomposite (ANC) (from 21.1414 to 7.1786 in Cu, and from 28.3497 to 0.9021 in Pb), then the last was presented by Raw Coconut Shell (RCS) (from 21.1414 to 19.2228 in Cu, and 28.3497 to 13.4420 in Pb). The reason why AC and ANC displayed more activity than RCS was because of surface area and porosity. Porosity in RCS is microporous with pores less than 40 angstroms, and that of the waste materials in water is larger (greater than 40 angstroms),so even if the RCS is activated (with large surface area) it cannot come in contact with all the waste materials that are larger;that is why it exhibited less activity. Nevertheless, to increase its activity it need to be activated (Jibril *et al*., 2012; Bin Azhari, 2010; Gaikwad and Mane, 2015).The result from this study is consistent with that of (Jibril *et al*., 2010; Song *et al*., 2013; Gaikwad and Mane, 2015; Buah and Dankah, 2016). Coconut shell was used to remove chromium (a similar harmful water pollutant like Pb and Cu) from water by Ayub and Khoradgani (2014). Song *et al*., (2013) used activated coconut shell to remove Pb from wastewater; and Buah and Dankwah (2016) used activated coconut to remove Pb, Cu and Cd from wastewater. This has demonstrated the ability of coconut shell (in raw or activated fashion) to remove heavy metals or other impurities from water (Amuda and Ibrahim, 2007; Mohan and Sheena, 2019).

Table 2 shows the UV-Vis spectra for adsorption of organic solvents by RCS, AC and ANC. Therein, the AC presented highest ability to absorb colour ,then the ANC. Whereas, the RCS has displayed more colour than its initial colour, which may be due to the colour of the coconut shell. It is in contrary with finding of Jibril *et al*., (2012) which reported that Raw Coconut Shell absorbed colours but not as effective as the AC and others. Colours are one of the undesirable water pollutants that are threat to organisms. Colours reduce photosynthetic ability and growth of biota. It is undesirable to eyes, and can be hazardous to humans. Thus, need to be removed from water (Shehu, 2019).

Population increase demands for more water quality and anthropogenic processes have made so much disturbances to our water (Ojekunle, 2017). Pb and Cu are problematic in water They cause toxicity, inhibition of biological sewage treatment, contamination of water and problems in agriculture use of sludge (Sperkling, 2007). Particularly, Cu is mostly found in water because of plumbing systems and other human activities (Sperkling, 2007; WSDH, 2016). A small amount of Cu is essential for health (example 2mg per day); whereas, exposure to high doses of Cu can cause health problems. Short term exposure to high doses can cause gastrointestinal distress, whereas, long-term exposure cause anaemia, liver and kidney disruption (WSDH, 2016).

There is no safe lead level; Pb comes from many sources and contaminate water especially from plumbing systems and anthropogenic sources. In children, Pb can cause damage to brain, central nervous system, red blood cells, kidney, liver, etc. It also causes lower IQs, hyperactivity, low concentration, low birth weight, abortion and many more. In adults, Pb cause high blood pressure, poor muscle coordination, nerve damage, infertility, vision and hearing impairment (WHO, 2011; Minnesota Department of Education/ Minnesota Department of Health, 2019). Therefore, there is need to treat wastewater. Conventional methods that are been used are expensive, unavailable in all cases require higher-skilled personnel because of their complexity, release of harmful chemicals to the environment or causing toxicity to water users among others (Shehu, 2019).To avail the situation search for a treatment material with more promising features (such as availability/accessibility, easy use, low price, etc.) is outmost; that is why we compare the effectiveness of RCS, ANC and AC. The RCS when improved will solve many prevailing water treatment problems. RCS is less cost, available, requires less expertise and intoxicated to biological systems. And it will solve the issue of environmental pollution through dumping of RCS waste. More studies are required to establish the diverse activities of RCS in certain conditions variability.

5. CONCLUSION

Raw coconut shell (RCS), activated carbon (AC) and activated nanocomposite (ANC) demonstrated diverse activities in removing of Pb, Cu and colour from wastewater.

6. REFERENCES

Abubakar, M.G. (2020). Preparation of adsorbent materials from coconut shells for multicontamiants water treatment. A Degree thesis submitted at the Department of Chemistry , Sokoto state University, Sokoto, Nigeria.

Amuda, O.S., & Ibrahim, A.O. (2007). Industrial wastewater treatment using natural material as adsorbent. *Africa Journal of Biotechnology* 5 (16):1483-1487.

Ayub, S., & Khoradgani, C. (2014). Adsorption for wastewater treatment by using coconut Activated Carbons Prepared from Coconut Husk. *Ghana Mining Journal* 16(2):36-41.

Bin Azhari, M.F. (2010). The effectiveness of activated carbon from coconut shell as wastewater pollutant removal. A BSc thesis submitted to University of Malaysia Pahang.

Buah, W.K., & Dankwah, J.R. (2016). Sorption of Heavy Metal Ions from Mine Wastewater by Shell. *Research Journal of Chemical Sciences* 4 (12):1-8.

Gaikwad, S., & Mane, S.J. (2015). Reduction of chemical oxygen demand by using coconut shell activated carbon and surgacane Bagasse fly ash. *International Journal of Science and Research 4* (7):642-645.

Israel Institute for Occupational Safety and Hygiene (2009). Water treatment plant operator. *www.ilo.org*

Jibril, M., Noraini, J., & Evuti, A.M. (2012). Removal of colour from wastewater using coconut shell activated carbon (CSWC) and commercial activated carbon (CAC). *Journal Teknologi* ,60:15-19. *www.journalteknologitm.my.com*

Minnesota Department of Education/Minnesota Department of Health (2019). Reducing lead in drinking water. A technical guidance and model for Minnesota's public schools.

Mohan, S.S., & Sheena, K.N. (2019). Waste water treatment using coconut shell activated carbon and laterite as low cost adsorbents. *International Journal of Engineering and Technology* 6(6):306-309.

Ojekunle, Z.O. (2017). Groundwater quality attrition by mechanic workshop activities in Abeokuta Metropolis, Ogun state, Nigeria. *Merit Research Journal of Environmental Science and Toxicology* 5(2):018-024.

Shehu, Z. (2019). Montmorillonite-silica nanocomposite for dye removal from solution. *Advances in Applied Science and Technology* 3:1-12.

Song, C., Wu, S., Cheng, M., Tao, P., Shao, M., & Gao, G.(2013). Adsorption studies of coconut shell carbons prepared by KO activation for removal of lead (11) from aqueous solution. *Sustainability* 6:86-98.

Sperkling, M. (2007). Wastewater characteristics, treatment and disposal. London, UK: IWA Publishing.

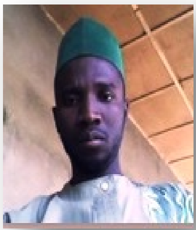
Theoye, C., Eyck, K.V., Bixco, D., Weemaes, M., & De Gueldre, G. (2018). Methods used for health risk assessment. *www.who.int*

Washington State Department of Health (2016). Copper in drinking water. *www.doh.wa.gov*

WHO (2011). Lead in drinking water. Background document for development of WHO guidelines for drinking water.

Authors

1 **Yusuf SarkinGobir**



He taught Biochemistry at Sultan Abdurrahman School of Health Technology Gwadabawa (SASHT), Sokoto State, few years ago. He is presently a tutor of Biology at the department of Biology, Shehu Shagari College of Education, Sokoto State. He holds Bachelor's degree in Biochemistry from Usman Danfodiyo University Sokoto (UDUS). And Master of Science Degree (M.Sc) in Public Health from Maryam Abacha American university of Niger Maradi (MAAUN). His research interest is Public health and environment.

2 **Malami Dikko**

He is currently a staff at Sultan Abdurrahman School of Health Technology Gwadabawa (SASHT), Sokoto State, Nigeria. His is well known researcher with many scholarly articles in international journals and conferences.

3 **Zubaida Abubakar Ladan**

She is currently a staff at department of Biology, Shehu Shagari College of Education, Sokoto State, Nigeria. She is well known researcher with many scholarly articles in international journals and conferences.